

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appellant:	Rijks, <i>et al.</i>	Docket No.:	EPC-016
Serial No.:	10/537,591	Art Unit:	2836
Filed:	June 6, 2005	Examiner:	Lucy M. Thomas
For:	Driving of an Array of Micro-Electro-Mechanical-System (MEMS) Elements		

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

APPEAL BRIEF

Dear Sir:

This Appeal Brief is respectfully submitted in connection with the above-identified application in response to the Final Rejection mailed September 24, 2008. A Notice of Appeal was filed on January 26, 2009.

REAL PARTY OF INTEREST (37 C.F.R. 41.37(c)(1)(i))

The present application is assigned to NXP B.V. The assignment was recorded August 17, 2007, and appears at reel 019719/0843. The real party of interest is EPCOS AG, who purchased the present application from NXP B.V.

RELATED APPEALS AND INTERFERENCES (37 C.F.R. 41.37(c)(1)(ii))

Appellant is not aware of any related appeals or interferences.

STATUS OF CLAIMS (37 C.F.R. 41.37(c)(1)(iii))

Claims 1-9 and 11-20 stand finally rejected. No claims have been allowed. Claim 10 was previously canceled. Therefore, claims 1-9 and 11-20 are the subject of this appeal. The claims on appeal are reproduced in the Claims Appendix.

STATUS OF AMENDMENTS (37 C.F.R. 41.37(c)(1)(iv))

An Amendment under 37 CFR §1.116 was filed on November 19, 2008 and was entered.

SUMMARY OF CLAIMED SUBJECT MATTER (37 C.F.R. 41.37(c)(1)(v))

The subject matter of independent claims 1 and 13 relates to a semiconductor device having MEMS elements with hysteresis curves exemplified by the Figures 1 and 3.

The MEMS elements described in the invention may be either MEMS switch or tunable capacitors. See, page 5, lines 4-5. The operation of a MEMS element exhibiting hysteresis is described using Figure 1, which shows the measured capacitance of a MEMS capacitor as a function of the control voltage. When the control voltage is increased to a closing voltage (V_{close}), the electrostatic forces between the top and bottom electrodes increase. Eventually, the top electrode of the capacitor collapses (e.g., in Figure 10, beam 10 is pulled down and a contact between part 8 and bottom electrode 4 and part 8 and bottom electrode 6 is established) thereby closing the air gap between the electrodes. Hence, the capacitance goes up (e.g., determined by the thickness of the dielectric between the collapsed plates). The plates remain in the closed state even if the control voltage is lowered below the closing voltage V_{close} . When, subsequently, the control voltage is decreased below an opening voltage V_{open} , the capacitor plates separate and the capacitance goes down again. Thus each MEMS element exhibits hysteresis in the switching voltage, i.e., the voltage

required to close the air gap (V_{close}) is different from the voltage required to open it again (V_{open}). See, Figure 1, and page 8, lines 7-13.

Figure 3 shows an example of the switching of an array containing two MEMS capacitor elements by tuning the closing voltage V_{close} and the opening voltage V_{open} for each capacitor to appropriate (different) values. By using an array consisting of two MEMS capacitor elements, four distinct states (00, 01, 10, 11) are possible. For example, to reach the 01 state, the control voltage has to be swept from V_4 to V_2 to V_3 . In particular, changing the control voltage from V_4 to V_2 closes both switches. Subsequently, changing the control voltage from V_2 to V_3 opens one of the MEMS elements but not the other (in Figure 3 reproduced below MEMS element corresponding to the upper curve opens while the MEMS element corresponding to the lower curve remains closed). So starting from a reset point (V_4 or V_2) each state can be activated with a predefined voltage sweep that is provided by a single input voltage.

It is particularly preferred that the characteristic hysteresis curves have different widths in an operational diagram of capacitance versus control voltage. This means that not only the opening voltage of a first MEMS element is different from that of a second MEMS element in the same array, but also that the voltage gap between opening and closing voltage is different for the first and the second MEMS element. In this manner, the hysteresis curve of a first MEMS element may lie fully within the hysteresis curve of the second MEMS element. See, page 4, lines 17-23.

With respect to independent claim 1, the electronic device comprises an array of micro-electromechanical system (MEMS) elements (e.g., Figures 10 and 11) including at least first and second MEMS elements e.g., as illustrated in Figure 3. The array is connected by an input (e.g., input 40 in Figure 11, see page 11, lines 31-32) and an output (e.g., third metal layer 42 in Figure 11, see page 11, lines 32-33) and provides a plurality of states at its output (e.g., 00, 01, 10, and 11 in

Figure 3). As illustrated in Figure 1, each of the first and second MEMS elements has a characteristic hysteresis curve, a first state (e.g., close state at a voltage greater than closing voltage V_{close}) and a second state (e.g., open state at voltage less than opening voltage V_{open}). The transition from the first to the second state is effected by an opening voltage V_{open} . The transition from the second to the first state is effected by a closing voltage V_{close} . Referring to Figure 3, the opening voltage V_3 and closing voltage V_1 of the first MEMS element is different from the opening voltage V_4 and closing voltage V_2 of the second MEMS element. The characteristic hysteresis curves that differ from the first MEMS element to the second MEMS element are designed such that the hysteresis curve having a smaller width is located fully within the width of the hysteresis curve having the larger width, e.g., in Figure 3, the hysteresis curve of the first MEMS element (highlighted in Figure 3 as reproduced below) is fully located within the hysteresis curve of the second MEMS element (shown below). The input is adapted for applying a single control voltage that is to be applied to all the MEMS elements whereby the various states of the array are obtained by varying the single control voltage (in Figure 3 both the upper and lower curves in Figure 3 are driven by control voltage V).

With respect to independent claim 13, the electronic device comprises a first MEMS element having a first characteristic hysteresis curve and a first state and a second state (highlighted in Figure 3 as reproduced below). A transition from the first to the second state is effected by a first opening voltage V_3 , and a transition from the second to the first state is effected by a first closing voltage V_1 . The electronic device includes a second MEMS element having a second characteristic hysteresis curve that is different than the first characteristic hysteresis curve (highlighted in Figure 3 as reproduced below). The second MEMS element has a first state and a second state wherein a transition from the first to the second state is effected by a second opening voltage V_4 , and a

transition from the second to the first state is effected by a second closing voltage V2. The second opening voltage V4 is different than the first opening voltage V3 and the second closing voltage V2 is different than the first closing voltage V1. The width of the first characteristic hysteresis curve (difference between V1 and V3) is smaller than the width of the second characteristic hysteresis curve (difference between V2 and V4). The first characteristic hysteresis curve is located fully within the second characteristic hysteresis curve (in Figure 3, the upper curve is fully located within the lower curve). A single common input is coupled to both the first MEMS element and the second MEMS element, wherein state transitions within the first MEMS element and within the second MEMS element are only effected by a control voltage applied to the single common input (both the upper and lower curves in Figure 3 are driven by control voltage V).

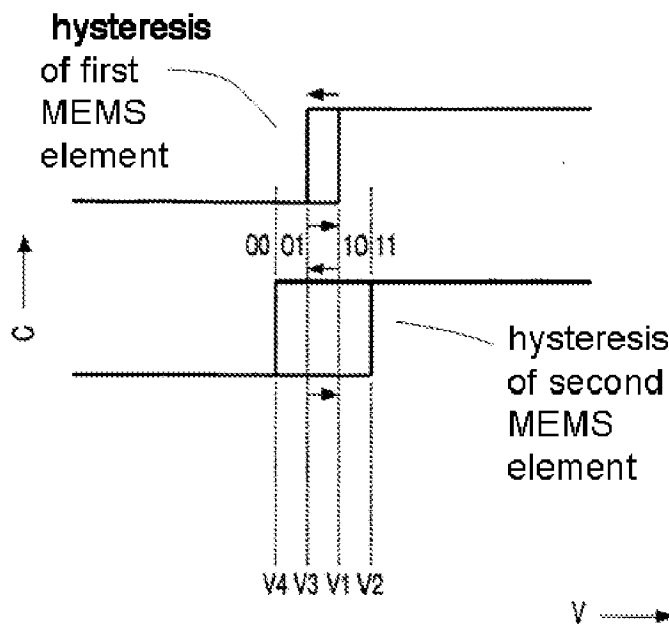


FIG. 3

GROUND OF REJECTION TO BE REVIEWED ON APPEAL (37 C.F.R. 41.37(c)(1)(vi))

(1) Whether claims 1-4, 6-9, and 11-20 are anticipated by Zavracky, *et al.* (U.S. Patent No. 4,674,180, hereinafter “Zavracky”) under 35 U.S.C. § 102(b).

(2) Whether claim 5 is patentable under 35 U.S.C. § 103(a) over Miles ‘532” in view of Sugahara and Miles, *et al.* (U.S. Patent No. 6,674,562, hereinafter “Miles ‘562”).

(3) Whether claims 1-4, 6-9, and 12-20 are patentable under 35 U.S.C. § 103(a) over Miles, *et al.* (U.S. Patent Application Publication No. 2004/0058532 A1, hereinafter “Miles ‘532”) in view of Sugahara, *et al.* (U.S. Patent No. 6,618,034 B1, hereinafter “Sugahara”).

(4) Whether claim 5 is patentable under 35 U.S.C. § 103(a) over Zavracky in view of Miles ‘562.

ARGUMENT (37 C.F.R. 41.37(c)(1)(vii))

It is respectfully submitted that claims 1-9 and 11-20 recite patentable subject matter under the provisions of 35 U.S.C. §§ 102 and 103. Each of the claims will be discussed in turn. Any claim not explicitly argued stands or falls with the claim from which it depends.

A. The rejected claims are patentable under 35 U.S.C. § 102(b) over Zavracky.

Zavracky discloses a series of parallel-connected micromechanical hysteretic shunts 10 (Zavracky, Figure 11). Each shunt 10 is connected with its respective fusible link to form an electrical current signature encoding system 15. Figure 13 of Zavracky discloses that neighboring cantilever beams 105, 109 are progressively shorter and this variation in length varies the threshold voltage of the shunt because longer cantilever beams require lower threshold voltages for closure. Zavaracky does not specifically disclose any relationship between the hysteresis width of a first MEMS element to the hysteresis width of a second MEMS element, which as described below is required by both independent claims 1 and 13.

1. Independent claim 1 is patentable in view of Zavracky.

Claim 1 requires that “the hysteresis curve having a smaller width is located fully within the width of the hysteresis curve having the larger width.” This requirement cannot be satisfied because Zavracky does not disclose changing the width of the hysteresis curves. Rather, Zavracky is silent regarding the opening voltage of the shunt, which would be essential for the width of hysteresis curves to differ. For example, upon an increase in cantilever beam length, if the opening voltage decreases by about the same as the decrease in threshold voltages for closure, the hysteresis width remains unchanged. In such a case, an increase in threshold voltage for closure arising from a decrease in cantilever beam length will not result in a wider hysteresis width. Consequently, the Examiner has failed to show that Zavracky teaches a change in hysteresis width of MEMS elements of different length.

In the Advisory Action, Examiner asserts Zavracky teaches these requirements.

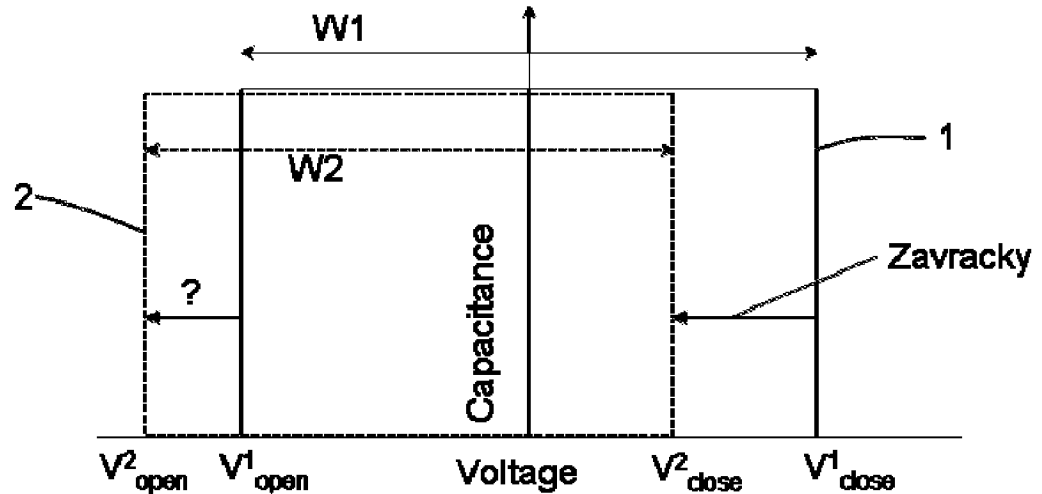
In Column 7, lines 40-44, Zavracky discloses, “each successive micromechanical shunt element 140, 141, 142, 143, 144, 145, 146, 147 has a slightly higher closure threshold voltage determined mainly by the dimensions of the cantilever beam contained therein,” and in Column 7, line 65- Column 8, line 1, discloses, “This variation in length provides one of several ways to vary the threshold voltage of the shunt because longer cantilever beam require lower threshold voltages for closure, all other characteristics being equal.” When all other characteristics being equal, *higher threshold voltage for closure results in a wider hysteresis width or higher retention, and therefore, the hysteresis curve having a smaller width or smaller threshold voltage will be fully located within the width of the hysteresis curve having the larger width.*”

Advisory Action, page 2 (emphasis added).

Appellant respectfully disagrees with Examiner’s conclusions. Claim 1 requires that “the hysteresis curve having a smaller width is located fully within the width of the hysteresis curve having the larger width.” This requirement cannot be satisfied because Zavracky does not disclose that the opening voltage *increases* when the closing voltage *decreases* so that the hysteresis curve

having a smaller width is located fully within the width of the hysteresis curve having the larger width. The opening voltage must increase when the closing voltage decreases for the hysteresis curve of a smaller width to be fully located within the width of the hysteresis curve having the larger width. *If the opening voltage decreases when the closing voltage decreases, neither of the hysteresis curves can be fully located within the other.*

This is illustrated in the figure below. Starting from a first hysteresis curve 1 having a first closing voltage (V_{close}^1) and a first opening voltage (V_{open}^1), a second hysteresis curve 2 is generated. Zavracky discloses that the first closing voltage (V_{close}^1) decreases to a second closing voltage (V_{close}^2) if the length of the cantilever beam is increased. If the opening voltage *decreases* when the closing voltage decreases, then the first opening voltage (V_{open}^1) will decrease to a second opening voltage (V_{open}^2). As illustrated below, in such a situation, the first hysteresis curve 1 *cannot be fully located* within the second hysteresis curve 2, e.g., the width of the first hysteresis curve W1 does not fully enclose the width of the second hysteresis curve W2. In fact, the wider hysteresis curve is fully located within the narrower hysteresis curve *only if* the first opening voltage (V_{open}^1) *increases, which is against any reasonable expectation*. Hence, the hysteresis curve having a smaller width is not fully located within a hysteresis curve having a larger width because Zavracky does not teach or suggest that the opening voltage *increases* while the closing voltage *decreases*.



Zavracky is silent regarding the opening voltage of the shunt. The opening voltage may either: (a) increase, (b) decrease, or (c) remain unchanged with an increase in length of the cantilever beam. As a technical fact, the direction of change of the opening voltage will follow the direction of change of the closing voltage. Hence, as the closing voltage *decreases*, the opening voltage will also *decrease*. The Examiner has not shown that the opening voltage will increase when the closing voltage decreases, a condition precedent for a hysteresis curve to be fully located within another hysteresis curve.

A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference. MPEP 2131 citing *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). In this case, Zavracky does not expressly or implicitly disclose that the opening voltage will increase when the closing voltage decreases due to an increase in length. Consequently, Zavracky does not expressly or inherently describe each and every element in claim 1. Hence, independent claim 1 is allowable over the prior art of Zavracky.

2. *Claim 2 is patentable in view of Zavracky.*

Claim 2 requires that “characteristic hysteresis curves and the corresponding opening and closing voltages differ from one MEMS element to another MEMS element.” As described above, Zavracky is silent regarding the opening voltage of the shunt, which would be essential to determine if the corresponding *opening voltages differ* from one MEMS element to another MEMS element. The Examiner has failed to show that Zavracky anticipates that opening voltages of each of the three MEMS element are different as required by claim 2. In view of the above, as well as for depending on allowable claim 1, dependent claim 2 is allowable over Zavracky.

3. *Claim 9 is patentable in view of Zavracky.*

Claim 9 requires that “the first state capacitances of the first and the second MEMS capacitor are different.” Zavracky fails to anticipate that the first and the second capacitance are different. Rather, Zavracky suggests there is no difference in capacitance because a variation in length provides one of several ways to vary the threshold voltage of the shunt because longer cantilever beams require lower threshold voltages for closure, *all other characteristics being equal*. Zavracky, column 7, line 65 - column 8, line 1. Hence, Zavracky discloses that other characteristics such as capacitances are held constant while lowering the threshold voltage. In view of the above, as well as for depending on allowable claim 1, dependent claim 9 is allowable over Zavracky.

4. *Claim 11 is patentable in view of Zavracky.*

Claim 11 requires “wherein the characteristic hysteresis curves of the first and second MEMS elements are *centered around a common centerline* in the operational diagram.” Emphasis added. As noted in Appellant’s specification, this increases the ease of driving the array, and it allows building up an array of MEMS elements to store logical states, wherein the distance between every logical state is equal to another distance. Specification, page 4, lines 24-28. Zavracky does

not disclose that the characteristic hysteresis curves of the first and second MEMS elements are centered around a common centerline in the operational diagram. Rather, even if the characteristic hysteresis curve of the first MEMS element is fully located within the characteristic hysteresis curve of the second MEMS elements, they may not be centered around a common centerline in the operational diagram. In view of the above, as well as for depending on allowable claim 1, dependent claim 11 is allowable over Zavracky.

5. *Claims 3-8, 12 are patentable in view of Zavracky.*

Claims 3-8 and 12 depend from claim 1 and add further limitations. It is respectfully submitted that these dependent claims are allowable by reason of depending from an allowable claim as well as for adding new limitations.

6. *Independent claim 13 is patentable in view of Zavracky.*

Claim 13 requires that “the first characteristic hysteresis curve is located fully within the second characteristic hysteresis curve.” This requirement cannot be satisfied because as described above, Zavracky does not disclose that the opening voltage *increases* when the closing voltage *decreases* so that the first hysteresis curve is located fully within the second hysteresis curve. The *opening voltage must increase when the closing voltage decreases* for the hysteresis curve of a smaller width to be fully located within the width of the hysteresis curve having the larger width. Claim 13 also requires that “the first characteristic hysteresis curve has a smaller width than the second characteristic hysteresis curve.” This requirement also cannot be satisfied because as described above, Zavracky does not disclose changing the width of the characteristic hysteresis curves.

A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference. MPEP 2131 citing *Verdegaal Bros.*

v. Union Oil Co. of California, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). In this case, Zavracky does not expressly or implicitly disclose that the opening voltage will increase when the closing voltage decreases due to an increase in length. Consequently, Zavracky does not expressly or inherently describe each and every element in claim 13. Hence, independent claim 13 is allowable over the prior art of Zavracky.

7. *Claims 14-20 are patentable in view of Zavracky.*

Claims 14-20 depend from claim 13 and add further limitations. It is respectfully submitted that these dependent claims are allowable by reason of depending from an allowable claim as well as for adding new limitations.

B. The rejected claims are patentable under 35 U.S.C. § 103(a) over Miles ‘532 in view of Sugahara.

Miles ‘532 discloses a plurality of IMOD devices fabricated in a large array so as to form pixels within a reflective display. Within such a reflective display, each IMOD device essentially defines a pixel which has a characteristic optical response when in the undriven state, and a characteristic optical response when in the driven state. Each pixel in an IMOD device may reflect red, blue, or green light when in the undriven state and may absorb light when in the driven state. Miles‘532, paragraph [0020].

During operation of the reflective display, the IMOD devices are rapidly energized, and de-energized. In order to keep the devices in its driven state, a bias voltage is applied to each IMOD device. However, it becomes extremely difficult to select an appropriate bias voltage, that can be applied to all of the IMOD's within the reflective display. The reason for this is that each IMOD device within the reflective display may have slight variations, which, in practice, result in a different release voltage (voltage at which the device returns to its undriven state), for each device. This makes it very difficult, if not impossible, to select a value for bias voltage that

will keep each of the IMOD's in its driven condition. The prior art device referred by Miles '532 exhibits no hysteresis, *i.e.*, the voltage required to attain the driven state is the same as the voltage required to attain the undriven state. Miles'532, paragraph [0021], and Figure 3.

To overcome the above problem, Miles '532 proposes modifying the IMOD device to have a hysteresis curve. Miles '532 teaches two independent embodiments. A first embodiment described with respect to Figures 4 and 5, and a second embodiment described with respect to Figures 6 and 7. The second embodiment has a wider hysteresis curve than the first embodiment. Miles'532, paragraph [0029]. However, Miles '532 never teaches implementing both embodiments together or simultaneously in a single array. All that Miles '532 teaches is to use IMOD devices with hysteresis instead of prior art devices that do not exhibit hysteresis.

Miles '532 also does not use a single control voltage to access the array. Rather each IMOD device is controlled by an independent bias voltage. Sugahara discloses a display device to display gray scale without using numerous signal lines and scanning lines. Each pixel in the display device includes a pair of the first fixed electrode and the first movable film electrode and a pair of the second fixed electrode and the second movable film electrode, the critical voltage required to displace the first and the second movable electrode is different. Sugahara, column 7, line 65 – column 8 line 5. Hence, the number of movable films to be selectively opened/shut is changed by changing the pixel voltage. Figure 11 and column 8 lines 34-37.

In the Advisory Action, Examiner asserts that Miles '532 in view of Sugahara teaches all the requirements of independent claims 1 and 13 for the reasons described below. "Examiner agrees that Miles and Sugahara do not specifically disclose that the MEMS elements are designed such that the hysteresis curve having a smaller width is located fully within the width of the hysteresis curve having next larger width. In paragraph 22, lines 11-18, Miles '532 teaches that the

hysteresis width variations of MEMS elements can be caused by several factors, such as thickness of the layers, and resistance variations of the lines (see paragraph 22, lines 11-18), and it would be obvious to one of ordinary skill in the art to design MEMS elements to have the smaller width elements fully located within the width of the next-larger width.” Advisory Action, pages 2-3. In other words, the Examiner argues that the intrinsic variations will result in devices satisfying these requirements. Appellant respectfully disagrees with Examiner’s conclusions.

1. Independent claim 1 is patentable over Miles ’532 in view of Sugahara.

A. Miles ’532 does not disclose that various states of the array are to be obtained by varying a single control voltage.

Claim 1 requires “wherein the input is adapted for applying a single control voltage that is to be applied to all the MEMS elements whereby the various states of the array are to be obtained by varying the single control voltage.” Miles ’532 does not teach or disclose that various states of the array are to be obtained by varying the single control voltage because the different hysteresis curves obtained due to variations are not predictable and may not be distinguishable. Because variations are statistical in nature, the voltages required for attaining the various states of the array (opening/closing voltages) cannot be known *a-priori* (hysteresis curve is not predictable), which is required to use a single control voltage. A single control voltage can not be used if the opening and closing voltage are not known *a-priori*. Further, the use of a single control voltage implies the existence of states that are distinguishable by the application of the control voltage. If the opening and closing voltage are too closely spaced together, the states can not be distinguished and a single control voltage can not be used.

As an illustration, in Figure 3 reproduced above, to be able to use a single control voltage, the voltages V1, V2, V3, and V4 must be known *a-priori* and must be distinguishable. A control voltage for programming a state 10 cannot be selected if the voltages V1 and V2 are

unknown, which would be the case if the different hysteresis curves are produced due to uncontrolled variations. Further, for attaining the state 10, the voltages V1 and V2 must be distinguishable so that a control voltage that is greater than V1 but less than V2 can be applied. If the difference between V1 and V2 is negligible as can be the case with devices produced by variation, the array may fail to reach the state 10, and hence a single control voltage can not be used to obtain the various state of the array. In view of the above, Miles '532 fails to teach or to suggest that the various states of the array are to be obtained by varying the single control voltage, which is required by claim 1.

B. Miles does not disclose a MEMS device with different widths because Miles '532 does not disclose variations in a device with hysteresis.

Miles '532 discloses that due to variations each device within a reflective display will have a different release voltage. Hence, it is impossible to select a single value for a control voltage V_{bias} that will keep each device in a driven condition. Miles'532, paragraph [0022], lines 11-21. In contrast to the Examiner's assessment, paragraph [0022] refers to variations in a device that does not exhibit *hysteresis*. This is expressly recited in paragraph [0023], lines 9-11 of Miles'532. Also see, Figure 3 of Miles '532 which does not have a hysteresis. Hence, the existence of different widths is moot because a width cannot be measured if there is no hysteresis curve. Consequently, Miles '532 does not disclose a MEMS device with different widths because Miles '532 does not disclose variations in a device with hysteresis.

C. The existence of variations does not disclose a MEMS device such that a hysteresis curve of a MEMS element is fully located within another hysteresis curve of another MEMS element.

Even if the variations of Miles '532 are applied to a device with a hysteresis, Miles '532 does not teach or suggest that the hysteresis curve of a MEMS element is fully located within

another hysteresis curve of another MEMS element. Paragraph [0022], lines 11-18 of Miles ‘532 discloses variations that arise due to the statistical nature of fabricating a small component. While such variations exist in all devices, they can not be used to create two devices with different hysteresis widths because these *variations are not predictable*. Evidence showing there was no reasonable expectation of success may support a conclusion of nonobviousness. MPEP 2143.02 citing *In re Rinehart*, 531 F.2d 1048, 189 USPQ 143 (CCPA 1976). Due to the statistical nature of variations, devices cannot be designed with any reasonable expectation of success. As an illustration, statistically, given identical devices, the chance that a selected first device has a hysteresis fully located within a second device is less than 25%. This is because for the second hysteresis curve to be within a first hysteresis curve, two conditions have to be satisfied. First, the second opening voltage must be larger than the first opening voltage (first condition). Second, the second closing voltage must be less than the first closing voltage (second condition). Each of these conditions have a 50% chance of occurring. Consequently, the chance that both conditions occur at the same time is only 25%. A typical manufacturing process requires an error of less than 1 device out of 1 million to about 1 billion devices. Devices designed to work by variation will result in large losses for the manufacturer as the bulk of these devices will be scrapped. Consequently, a person skilled in the art will *never* use the design proposed by the Examiner because the expectation of success is unreasonably low.

Claim 1 requires that “the hysteresis curve having a smaller width *is located fully* within the width of the hysteresis curve having the larger width.” Emphasis added. *Claim 1 is definitive*, and requires that the hysteresis curve having a smaller width *is* located fully within the width of the hysteresis curve having the larger width. The Examiner’s device cannot satisfy this element of predictability. For example, claim 1 does not recite that “*sometimes* the hysteresis curve having a

smaller width *may be* located fully within the width of the hysteresis curve having the larger width.”

In Miles‘532, due to variations, the hysteresis curve having a smaller width *may or may not be* located fully within the width of the hysteresis curve having the larger width. Nothing in Miles ‘532 definitely discloses that a curve having a smaller width is located fully within the width of the hysteresis curve having the larger width.

Sugahara does not overcome any of these deficiencies. In view of the above, independent claim 1 is allowable over the prior art of Miles‘532 in view of Sugahara.

2. Claim 2 is patentable over Miles ‘532 in view of Sugahara.

Claim 2 requires that “wherein the array includes at least three MEMS elements each having a characteristic hysteresis curve” and “the corresponding opening and closing voltages differ from one MEMS element to another MEMS element.” Miles ‘532 does not teach or suggest this requirement because in Miles‘532, due to variations, the corresponding opening and closing voltages *may or may not* differ from one MEMS element to another MEMS element. Nothing in Miles ‘532 definitely discloses that the opening and closing voltages *are different* from one MEMS element to another MEMS element.

Further claim 2 being dependent from claim 1 requires “wherein the input is adapted for applying a single control voltage that is to be applied to all the MEMS elements whereby the various states of the array are to be obtained by varying the single control voltage.” As claim 2 requires at least three MEMS elements, the possibility of using a single control voltage diminishes. For an array formed with variation, the possibility of the existence of a distinguishable range of voltage for an array with three MEMS elements is significantly less than an array with two MEMS element. Hence, Miles ‘532 does not teach or disclose that various states of the array are to be obtained by varying the single control voltage because the different

hysteresis curves obtained due to variations are not predictable and may not be distinguishable.

In view of the above, as well as for depending on allowable claim 1, dependent claim 2 is allowable over Miles '532 in view of Sugahara.

3. Claim 11 is patentable over Miles '532 in view of Sugahara.

Claim 11 recites “wherein the characteristic hysteresis curves of the first and second MEMS elements are centered around a common centerline in the operational diagram.” Even if a hysteresis curve having a smaller width is located fully within the width of the hysteresis curve having a large width, hysteresis curves of Miles '532 produced by variations may not be centered around a common centerline. There is no suggestion in Miles '532 that variation can produce characteristic hysteresis curves of the first and second MEMS elements centered around a common centerline in the operational diagram. In view of the above, as well as for depending on allowable claim 1, dependent claim 11 is allowable over Miles '532 in view of Sugahara.

4. Independent Claim 13 is patentable over Miles '532 in view of Sugahara.

As described above, in the Advisory Action, Examiner asserts that Miles'532 in view of Sugahara teaches all the requirements of claims 13. Appellant respectfully disagrees.

Claim 13 requires “wherein state transitions within the first MEMS element and within the second MEMS element are only effected by a control voltage applied to the single common input.” Miles '532 does not teach or disclose that state transitions within the first and the second MEMS elements are *only* effected by a control voltage because the state transitions obtained due to variations are not predictable and may not be distinguishable. Because variations are statistical in nature, the voltages required for attaining the state transitions (opening/closing voltages) cannot be known *a-priori* (as not predictable), which is required to use a control

voltage applied to the single common input. A control voltage can not be used if the opening and closing voltage are not known *a-priori*. Further, the use of a control voltage implies that the state transitions are distinguishable by the application of the control voltage.

Claim 13 also requires that “the first characteristic hysteresis curve *is located fully* within the second characteristic hysteresis curve.” Emphasis added. Miles ‘532 does not teach or suggest this requirement because in Miles ‘532, due to variations, the first characteristic hysteresis curve *may or may not be* located fully within the second characteristic hysteresis curve. Nothing in Miles ‘532 *definitely* discloses that the first characteristic hysteresis curve is located fully within the second characteristic hysteresis.

Sugahara does not overcome any of these deficiencies. In view of above, independent claim 13 is allowable over the prior art of Miles ‘532 in view of Sugahara.

5. Claim 19 is patentable over Miles ‘532 in view of Sugahara.

Claim 19 recites “wherein application of the control voltage to the single common input can cause the variable capacitor to take on at least four different capacitance values.” Nothing in Miles ‘532 suggests that the variable capacitor takes on at least four different capacitance values. Rather, due to the unpredictability of variation, it is impractical to have more than two states. In particular, as claim 19 depends on claim 13 which requires “wherein state transitions within the first MEMS element and within the second MEMS element are only effected by a control voltage applied to the single common input.” Because variations are statistical in nature, the number of different capacitance values or voltages required for attaining the state transitions (opening/closing voltages) cannot be known *a-priori* (as not predictable), both of which is required to use a control voltage applied to the single common input. A control voltage can not be used if either the opening and closing voltage or the different capacitance values are not known *a-priori*. In view of the above, as

well as for depending on allowable claim 13, dependent claim 19 is allowable over Miles '532 in view of Sugahara.

6. Claims 14-18 and 20 are patentable over Miles '532 in view of Sugahara.

Claims 14-18 and 20 depend from claim 13 and add further limitations. It is respectfully submitted that these dependent claims are allowable by reason of depending from an allowable claim as well as for adding new limitations.

C. Claim 5 is patentable under 35 U.S.C. § 103(a) over Zavracky in view of Miles '562.

Claims 5 depends from claim 1 and adds further limitations. As described above, claim 1 is patentable over Zavracky. Miles '562 does cure these deficiencies. Rather, Miles '562 discloses a MEMS device where the input for a control voltage is from a transistor. Miles '562, Figure 4C. Miles '562 does not cure deficiencies of independent claim 1. It is respectfully submitted that dependent claim 5 is allowable over Zavracky, in view of Miles '562, by reason of depending from an allowable claim as well as for adding new limitations.

D. Claim 5 is patentable under 35 U.S.C. § 103(a) over Miles '532 in view of Sugahara and Miles '562.

Claims 5 depends from claim 1 and adds further limitations. As described above, claim 1 is patentable over Miles '532 in view of Sugahara. Miles '562 does cure these deficiencies. Rather, Miles '562 discloses a MEMS device where the input for a control voltage is from a transistor. Miles '562, Figure 4C. Miles '562 does not cure deficiencies of independent claim 1. It is respectfully submitted that dependent claim 5 is allowable, over Miles' 532 in view of Sugahara and Miles '562, by reason of depending from an allowable claim as well as for adding new limitations.

CONCLUSION

For the foregoing reasons, Appellant respectfully submits that the final rejection of 1-4, 6-9, and 11-20 under 35 U.S.C. § 102 and claims 1-9, and 12-20 under 35 U.S.C. § 103 is improper and respectfully requests that the Board of Patent Appeals and Interference so find and reverse these rejections.

To the extent necessary, Appellant petitions for an Extension of Time under 37 C.F.R. § 1.136. Please charge any fees, or credit any overpayments, in connection with the filing of this paper, including extension of time fees, to the Deposit Account No. 50-1065.

Respectfully submitted,

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Date

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CLAIMS APPENDIX

1. An electronic device comprising:

an array of micro-electromechanical system (MEMS) elements including at least first and second MEMS elements, said array being connected by an input and an output and providing a plurality of states at its output,

wherein each of the first and second MEMS elements has a characteristic hysteresis curve, a first state and a second state, and

wherein a transition from the first to the second state is effected by an opening voltage, and a transition from the second to the first state is effected by a closing voltage, the opening voltage and closing voltage of the first MEMS element being different from the opening voltage and closing voltage of the second MEMS element, and

wherein the characteristic hysteresis curves differing from the first MEMS element to the second MEMS element are designed such that the hysteresis curve having a smaller width is located fully within the width of the hysteresis curve having the larger width, and

wherein the input is adapted for applying a single control voltage that is to be applied to all the MEMS elements whereby the various states of the array are to be obtained by varying the single control voltage.

2. An electronic device as claimed in claim 1, wherein the array includes at least three MEMS elements each having a characteristic hysteresis curve, such that the opening voltage is different from the closing voltage, which characteristic hysteresis curves and the corresponding opening and closing voltages differ from one MEMS element to another MEMS element.

3. The device of claim 1, wherein the MEMS elements in the array are connected in parallel.
4. The device of claim 1, wherein the number of MEMS elements in the array is in the range from 2 to 10.
5. The device of claim 1, wherein the input for a single control voltage is connected to a transistor.
6. The device of claim 1 comprising a plurality of arrays of MEMS elements, each array having an input for a single control voltage.
7. The device of claim 1, wherein each of the MEMS elements in the array has a fixed electrode and a movable electrode that is movable towards and away from the fixed electrode by application of the closing and the opening voltage respectively, such that in the first state the distance between the fixed and the movable electrode is smaller than in the second state, which movable electrode is suspended substantially parallel to the fixed electrode and anchored to a support structure by at least one cantilever arm having a spring constant, which MEMS element is provided with an actuation electrode with an actuation area for provision of the closing and opening voltages.
8. The device of claim 1, wherein the first and second MEMS elements in the array have different characteristic hysteresis curves in that actuation areas of control electrodes of the first and second MEMS elements are different and/or spring constants of cantilever arms are different.

9. The device of claim 7, wherein at least one dielectric layer having a dielectric permittivity is present between the fixed and the movable electrode, such that the MEMS element is a MEMS capacitor, of which capacitor the first state has a first state capacitance, and a first and a second MEMS capacitor in the array have different characteristic hysteresis curves in that the first state capacitances of the first and the second MEMS capacitor are different.

11. The device of claim 1, wherein the characteristic hysteresis curves of the first and second MEMS elements are centered around a common centerline in the operational diagram.

12. Method for driving an array of micro-electromechanical system (MEMS) elements according to claim 1, wherein a single control voltage is applied in common to the MEMS elements in the array, which voltage is varied to obtain the various states of the array.

13. An electronic device comprising:

a first MEMS element having a first characteristic hysteresis curve and a first state and a second state, a transition from the first to the second state being effected by a first opening voltage, and a transition from the second to the first state being effected by a first closing voltage;

a second MEMS element having a second characteristic hysteresis curve that is different than the first characteristic hysteresis curve, the second MEMS element having a first state and a second state wherein a transition from the first to the second state is effected by a second opening voltage, and a transition from the second to the first state is effected by a second closing voltage, the second opening voltage being different than a first opening voltage and the second closing voltage being different than the first closing voltage, wherein the first characteristic hysteresis curve has a smaller width than the second characteristic hysteresis curve and wherein the first characteristic

hysteresis curve is located fully within the second characteristic hysteresis curve; and

a single common input coupled to both the first MEMS element and the second MEMS element, wherein state transitions within the first MEMS element and within the second MEMS element are only effected by a control voltage applied to the single common input.

14. The device of claim 13, wherein the first and second MEMS elements each include a fixed electrode and a movable electrode that is movable towards and away from the fixed electrode by application of the control voltage applied to the single common input.

15. The device of claim 14, wherein the distance between the fixed and the movable electrode is smaller in the first state than in the second state.

16. The device of claim 14, wherein the movable electrode is suspended substantially parallel to the fixed electrode and anchored to a support structure by at least one cantilever arm having a spring constant, each MEMS element further having an actuation electrode with an actuation area for providing the closing and opening voltages.

17. The device of claim 16, wherein the first and second MEMS elements each include a dielectric layer having a dielectric permittivity between the fixed and the movable electrode, such that each MEMS element is a MEMS capacitor.

18. The device of claim 13, wherein the first MEMS element comprises a first MEMS capacitor and wherein the second MEMS element comprises a second MEMS capacitor such that the electronic device comprises a variable capacitor.

19. The device of claim 18, wherein application of the control voltage to the single common input can cause the variable capacitor to take on at least four different capacitance values.

20. The device of claim 19, further comprising at least one further MEMS element coupled to the single common input, wherein application of the control voltage to the single common input can cause the variable capacitor to take on more than four different capacitance values.

EVIDENCE APPENDIX

None

RELATED PROCEEDINGS APPENDIX

None